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Title Page

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TITLE

THE EFFECT OF PARTICLE SIZE DISTRIBUTION UPON THE PHYSICAL PROPERTIES OF CARBON BRUSH MATERIALS

ABSTRACT

The results of a study into the effects of particle size distribution upon the ultimate physical properties of carbon brush material are reported.

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CONCLUSIONS

The effect of a simple change in particle size distribution does not result in an equally simple modification of ultimate physical properties in a carbon brush material. A striking anomaly is reported and illustrated graphically. The necessity for further work is indicated.

By cutting out this rectangle and folding on the center line, the above information can be fitted into a standard card file.

For list of contents—drawings, photos, etc. and for distribution see next page (FN-610-2).

INFORMATION PREPARED FOR Carbon Products Engg. Divn., Large Motor & Generator Divns.

TESTS MADE BY Ralph Perrino, Frank Raczynski

COUNTERSIGNED ______ DIV. ______

DIVISIONS Works Laboratory LOCATION Schenectady, N. Y.

THE EFFECT OF PARTICLE SIZE DISTRIBUTION UPON THE PHYSICAL PROPERTIES OF CARBON BRUSH MATERIALS

The ultimate physical properties of a carbon brush material depend not only upon the raw materials involved in its manufacture but also upon the processing variables including mixing, thermal treatment, particle size distribution before pressing, the pressing itself, and perhaps others. The author has been engaged for some time in the study of the fundamental nature of several of these variables notably the effect of change of one raw material, coal-tar pitch and its reaction with sulfur. He has felt since his introduction to the problems involved in carbon brush manufacture that particle size distribution has not been properly recognized as one of the major variables. A study into the effect of particle size distribution was therefore undertaken. This report constitutes a summary of the initial results obtained.

This study was made upon Grade 377 material as obtained from the factory as prebake cakes. Six separate particle size distributions were artificially made up, then pressed into both laboratory sized and factory sized blocks and carried through the regular heat treatment procedure. These six mixtures were given the laboratory grade numbers F206A-F. Particle size distributions which were chosen for study are shown in the following tabulation:

TABLE I

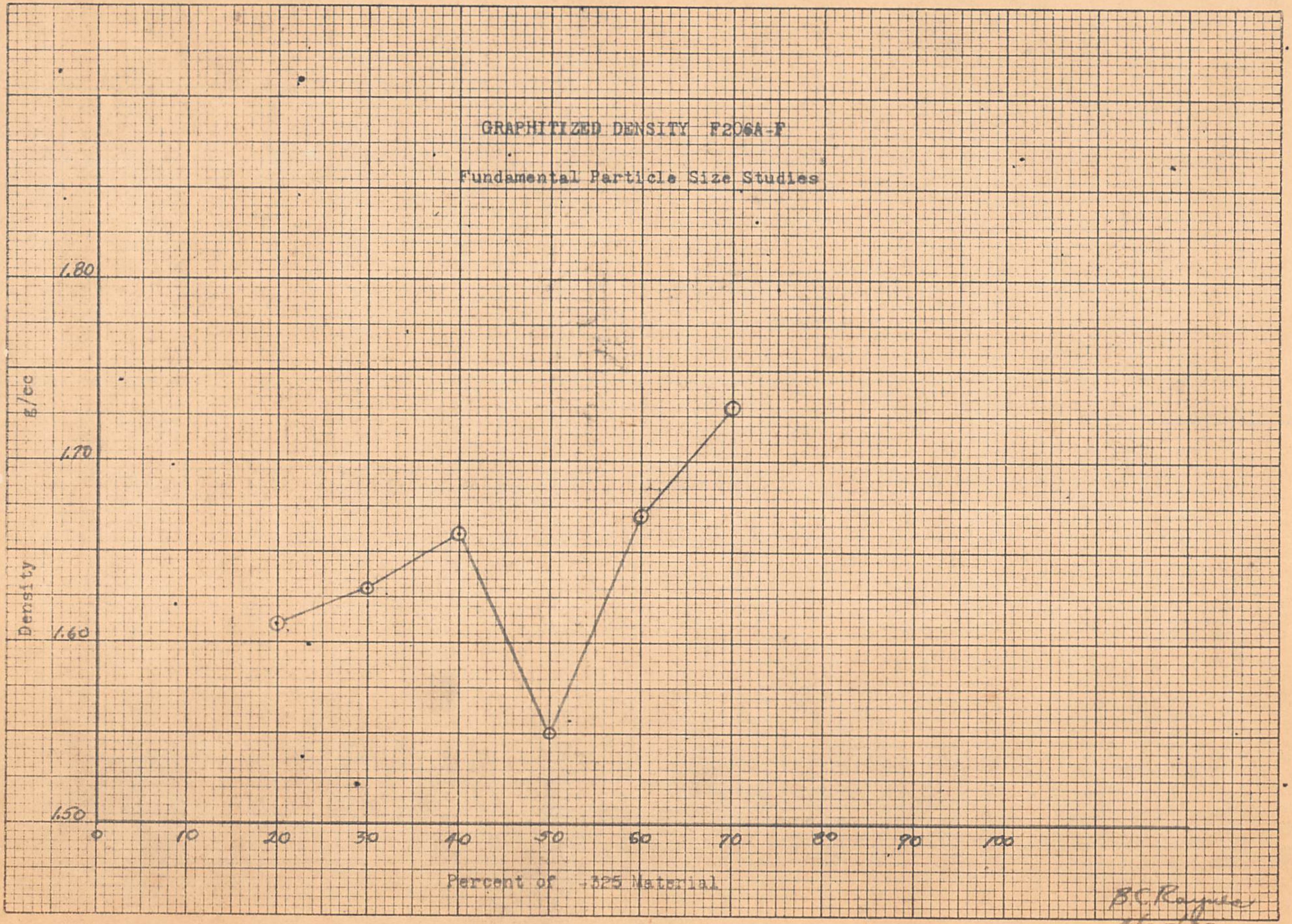
Particle Size Distribution	F205A	F206B	F206C	F206D	F206E	F206F
+ 100)) + 200)	30%	30%	30%	30%	30%	30%
+ 325	50%	40%	30%	20%	10%	0%
- 325	20%	30%	40%	50%	60%	70%

It is to be noted here that several of these particle size distributions cannot readily be obtained by simple grinding in the laboratory impact grinder. It was necessary to screen out the different fractions, for example -325 mesh material, and make synthetic blends. However, the purpose of this investigation was to discover any effect upon physical properties caused by particle size alone; it was not desired to investigate the behavior of the grinding equipment. It was hoped that from the results of this initial study, the extremely large range covered, 20% to 70% -325 mesh material as shown in Table I, could be narrowed down and allow for the study of normally ground material.

Since the percentage of ∤ 100 and ∤ 200 mesh materials was held constant and the percentage of -325 mesh material was increased, it would be expected that blocks pressed at constant pressure from each succeeding mixture would exhibit successively increasing densities. In general this was found to be true. A striking anomaly appears, however, with the material containing 50% -325 mesh particles. This material, F206D, is completely out of line with its neighbors. Several questions are raised by this peculiarity: Data from one study alone does not definitely establish the existence or non-existence of any fact. On the other hand a duplicate study which does not reveal this change in slope of the properties curve also does not establish the existence or non-existence of the fact. It should be very carefully noted that the material which has been found to be out of line in this study corresponds very closely to the standard Grade 377 physical properties. This is true not only in the particle size distribution before pressing but also in its ultimate physical properties. F 206D appears to be quite a normal Grade 377 material. If there was some error in the experimental procedure, it appears to be quite a remarkable co-incidence that the material most like the Grade 377 should have been the one to be in error.

The factory Grade 377 prebake cakes were ground in the Carbon Products Laboratory and were given all possible care during the course of this experiment. The possibility of an error in the grinding and pressing operations is not denied but seems improbable. Since factory size blocks pressed independently in Building 64 also show the F206D material to be unusual as compared with the others, the error would appear to be due to the grinding operation. In this work the author had the assistance of several members of Mr. T. Lundy's group and has no reason to feel that any unusual handling was given the F206D material. Since it appears that the possibility of error is reasonably small, then the change in slope may be regarded as a real one.

Turning now to the properties exhibited by the other five grain size distributions, reference should be made to the attached plot of graphitized density versus percent -325 material. Only density is plotted since the normal relationships between other physical properties and density are maintained. Table II presents a complete summary of graphitized data both for laboratory blocks and for factory size blocks. In general, as the percentage of fine material (-325 mesh) is increased the density, transverse strength, and hardness increase. The resistivity, of course, exhibits an inverse relationship. At the beginning of this study, it was felt that the material containing only 20% -325 mesh material would not bind together to give a strong carbon brush material. Furthermore it was felt that the material containing



B.C. Raynes
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70% -325 particles might be too difficult properly to press. Both of these expectations were unfounded. An examination of the graph will show that the 20% -325 material has a relatively high transverse strength of 4800-5100 pounds per square inch. The brush grade containing 70% -325 mesh material exhibits the extremely high transverse strength of 7700-8900 pounds per square inch. Table II presents the complete graphitized data on both the laboratory and factory blocks.

TABLE II

F206A-F GRAPHITIZED DATA

% -325 Mesh	Brush Grade	Density	Hs	HR	Transverse Strength	Resistivity	
20%	F206A	1.61	71	201	5100	0.00185	
30%	F206B	1.63	4	202	6100	0.00178	
40%	F206C	1.66	77	208	7600	0.00176	
50%	F206D	1.55	69	190	3200	0.0022	Laboratory Blocks
60%	F206E	1.67	78	210	7900	0.00171	
70%	F206F	1.73	85	215	8900	0.00156	
20%	F206A	1.60	57	202	4800	0.00198	
30%	F206B	1.58	68	204	5000	0.00193	
40%	F206C	1.62	71	206	5900	0.00190	Factory Slabs
50%	F206D	1.52	60	183	2700	0.00238	
60%	F206E	1.62	76	212	6600	0.00176	
70%	F206F	1.68	83	217	7700	0.00162	

It should be kept in mind that several of the processing variables are not always completely independent. Although in this study an attempt was made to negate the variables introduced in the grinding operation, it was not possible to isolate the effects of pressure. These materials were pressed at constant pressure corresponding to 27,000 pounds per square inch of block area. It would be assumed that in the future study a change in pressure from this value would merely change the magnitude of the physical properties. The strong possibility exists, however, that this assumption would be an error; the ultimate physical properties of carbon brush material are a function of a number of variables which may or may mot be independent.

Bertram C. Raynes
SCHENECTADY WORKS LABORATORY